PALEO-CHANNELS OF SINGKAWANG WATERS WEST KALIMANTAN AND ITS RELATION TO THE OCCURRENCES OF SUB-SEABOTTOM GOLD PLACERS BASED ON STRATA BOX SEISMIC RECORD ANALYSES

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ABSTRACT

Strata box seismic records were used to analyze sub-seabottom paleochannels in Singkawang Waters, West Kalimantan. Based on the analyses, it can be identified the distribution and patterns of paleochannels. Paleo channel at northern part of study area interpreted as a continuation of Recent coastal rivers; and at the southern part, the pattern radiates surround the cone-shaped morphology of islands, especially Kabung and Lemukutan Islands.

Paleochannels of the study area belong to northwest Sunda Shelf systems that terminated to the South China Sea. A study on sequence stratigraphy was carried out to better understanding sedimentary sequences in the paleochannels. This study is also capable of identifying placer deposits within the channels.

Based on criterias of gold placer occurrence such as existence of primary gold sources, intense chemical and physical weathering to liberate gold grains from their source rocks of Sintang Intrusive.

Gravity transportation that involved water media, stable bed rock and surface conditions, caused offshore area of Singkawang fulfill requirements for gold placer accumulations. Chemical and physical whethering proccesses from Oligocene to Recent, approximately 36 million, might be found accumulation of gold placer on the seafloor.

Based on grain size analyses, the study area consisted of sand 43.4%, silt 54.3% and clay 2.3%. Petrographic examination of the sample shows gold grains about 0.2%.

Keywords: paleochannels, strata box seismic records, gold placer.

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S A R I

Rekaman seismik strata box digunakan untuk menganalisa sungai purba bawah permukaan di Perairan Singkawang, Kalimantan Barat. Berdasarkan hasil analisis data strata box dapat diidentifikasi sebaran dan pola sungai purba. Sungai purba di bagian utara daerah penelitian ditafsirkan sebagai kelanjutan sungai sekarang, dan di selatan sungainya berpola memancar yang berasal dari pulau-pulau bermorfologi kerucut, seperti Pulau Kabung dan Lemukutan. Sungai purba daerah penelitian termasuk pada sistem sungai purba Paparan Sunda barat laut berakhir di Laut Cina Selatan. Suatu kajian sekuen stratigrafi dilaksanakan untuk lebih memahami sekuen-sekuen sedimen dalam sungai purba. Kajian ini juga mampu mengidentifikasi endapan-endapan plaser dalam alur tersebut. Berdasarkan kriteria pembentukan emas plaser atau letakan, seperti terdapatnya sumber emas primer, pelapukan kimia dan fisika yang sangat intensif untuk membebaskan butiran-butiran emas dari batuan induknya yaitu Batuan Terobosan Sintang. Transportasi gaya berat yang melibatkan media air, kondisi batuan dasar dan permukaan yang stabil, membuat daerah lepas pantai Singkawang memenuhi kriteria untuk akumulasi emas letakan. Proses pelapukan kimia dan fisika mulai dari Oligosen hingga Resen, sekitar 36 juta tahun memungkinkan dijumpainya akumulasi emas letakan di dasar laut. Berdasarkan hasil analisa besar butir daerah penelitian terdiri dari pasir 43,4%, lanau 54,3% dan lempung 2,3 %. Uji petrogafi menunjukan kandungan emas sekitar 0,2%.

Kata kunci: *sungai purba, rekaman seismik strata box, emas letakan.*

INTRODUCTION

Administratively study area belongs to Singkawang City, West Kalimantan Province and geographically is located at coordinates 108°48’ to 108°51’ east longitudes and 0°48’ to 0°51’ north latitudes (Figure 1).

A subbottom geological mapping of the survey area was carried out using a strata box equipment system. This system is a high resolution shallow reflection seismic designed for shallow coastal water survey, capable to penetrate upto 50 meters below seabottom. This method is also portable which combined transmitter and reciever in one unit transducer, acoustic signals transmitted to seabeds will be received by the same transducer unit. The strata box sencor unit works to process all acoustic signals; while seismic records from data acquisition performed in digital or printed out as analog records. Frequence used is 10 kHz.

Gold placer resources in Singkawang’s coastal area are abundances revealed from Chinese migrants arrivals since the end of 18th century as placer gold miners (Herman, 2007). A river system, downstreamed to off Singkawang and upstreamed to primary gold sources located in mountainous area – southeast of Singkawang City. It is expected to transport its gold placer to offshore areas. Primary gold sources were also derived from islands and coastal zone southwest of Singkawang City as mineralizations also occurred in these places. The long time erosional process, since mineralization at Oligocene Epoch (approximately 36 million years ago), no significant geology events such as earthquakes and volcano eruptions took place (Suwarna and Langford, 1993). The stable geological condition supports the idea of very significant placer gold accumulations in Singkawang shallow sea.

At global maximum glacial, approximately 18,000 years ago, when sea level minus 120 meters below present sealevel, Sunda Shelf was a landmass among Kalimantan, Sumatera and Java islands (Lacroix and Bywater, 2004), where the study area is located. Nowadays, these paleo-channels are covered by Holocene marine sediments (Figure 2).

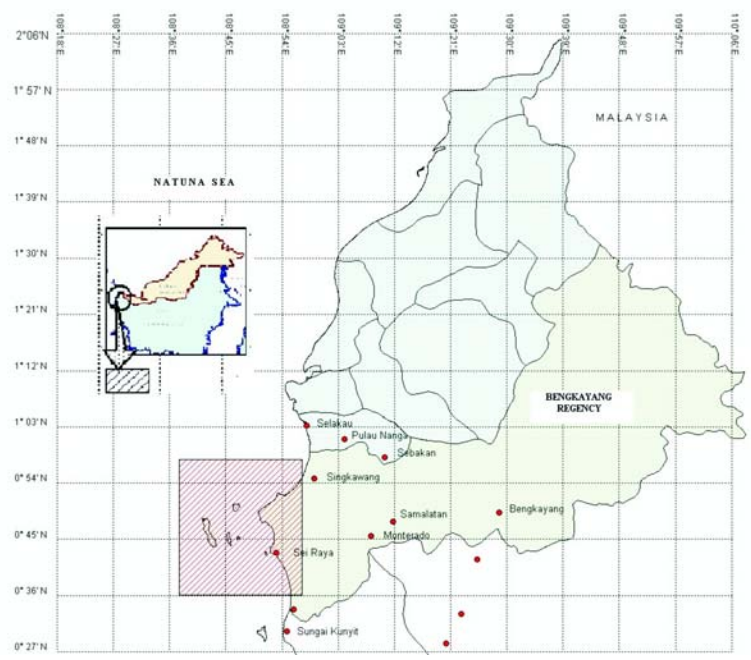

Figure 1. Study area.

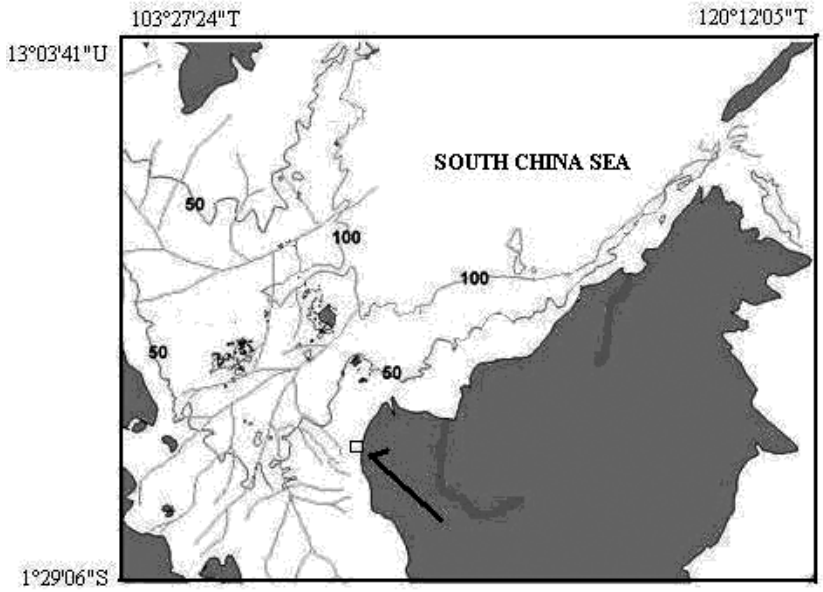

Figure 2. Regional paleo-channels system in northwest Sunda Shelf ((Lacroix and Bywater, 2004)

According to Suwarna and Langford, 1993, geology of the study area composed of many rock units (Figure 3), from old to young : Raya Volcanics (Klr) of Late Cretaceous - Jurassic relatively resist to erosional process formed steep mountainous area, and small islands off Singkawang mainland. Mensibau Granodiorite (Klm) widely distributed and formed Singkawang Batholite which occurred as northwestern headland. Sintang Intrusives (Toms) produced much of stocks and sub-volcanic dykes spread all over the Sheet area. Quarternary sediments are consisted of dissected alluvium (Qat), flood plain alluvial and swamp (Qa) and Recent littoral (Qc) deposits.

The study area belongs to West Kalimantan Block (Herman, 2007). In this block, andesite, dacite and pyroclastics of Triassic – Jurrasic are widely distributed; which were intruded by Cretaceous granitic batholite rocks. Most of this batholite is composed by tonalite and granodiorite of calc-alcaline series. These granitic intrusive rocks were closely related to lithospheric plate subduction in the north. This southwest directed oceanic plate has subducted beneath continental plate of Kalimantan during Late Cretaceous to Tertiary in South China Sea, and has resulted in granitic and dacitic intrusions.

Kalimantan Island was formed by granitic igneous rocks, intrusive of calc-alkaline to

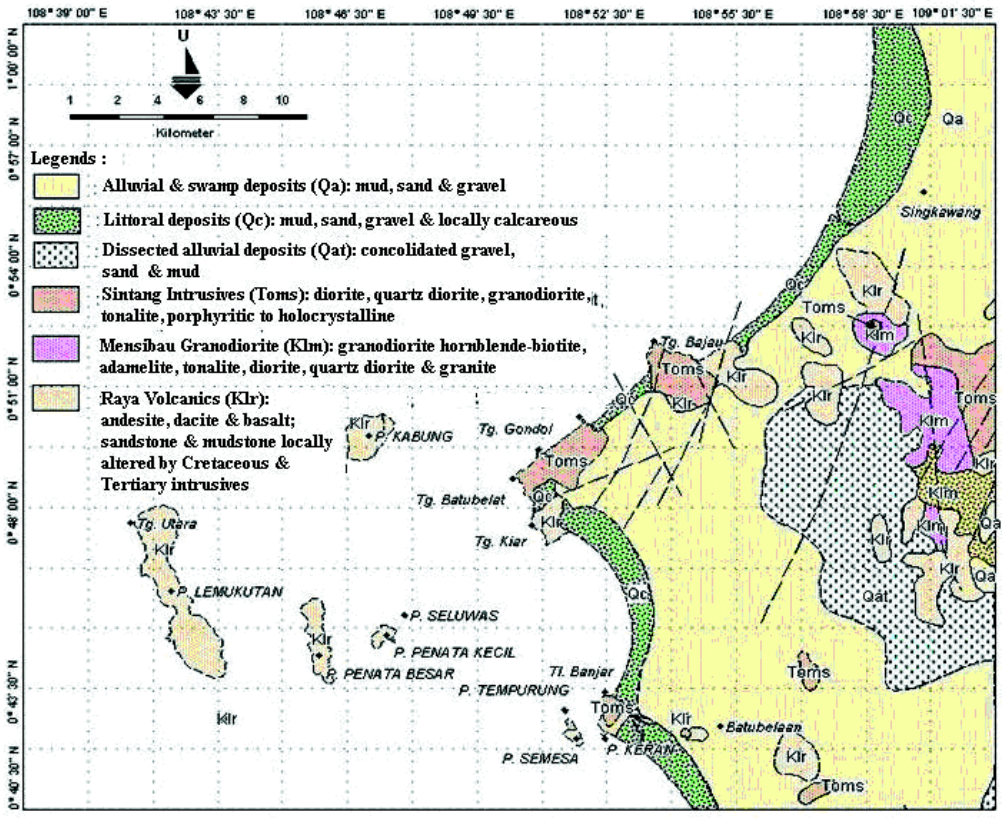

Figure 3. Islands and Singkawang coastal area geology.

alkaline series (tonalite, granodiorite, monzonite, granite riebeckite), few of metamorphic and sedimentary; which all of Paleozoicum to Quarternary ages (Herman, 2007). At Quarternary stated that gold particles were found in sediment units deposited above Pleistocene sediments and alluvium.

Gurnadi and Kurnia (2007) found out that quite vast distribution of alluvial deposits around Monterado area (approximately 25 kilometers southeast of Singkawang City) are consisted of colluvial, river alluvial deposits, swamp deposits and coastal deposits. The potential economic alluvial gold occurred in colluvial deposits and river deposits. River alluvial deposits in this area was resulted from Raya River activity.

Colluvial deposits are relatively thin layers (thickness 1 – 2 meters) mostly took place in river upstream occupy mountainous area; while paleo-channel alluvial deposits occurred along river channels with relatively thicker deposits (2 – 5 meters) (Gunradi, R. and Kurnia, E., 2007).

Gold grain, generally angulated and semi-angulated, needles-like and flaky, suggesting that gold grains were transported closed to their primary sources (Gunradi, R. and Kurnia, E., 2007).

METHODS

The seismic survey was directed to map these paleo-channels; where abundances of secondary potential gold placer deposits possibly accumulated (Gunradi, R. and Kurnia, E., 2007), (Herman, 2007) and (Levson, V.M. and Giles, T.R., 1995). Total seismic line lengths were about 300 kilometers for mapping purpose of all paleo-channels in the study area (Figure 4).

The interpretation of each paleo-channel from the records was done based on similarities of river profiles and guided by river patterns in the coastal area of Singkawang. During global maximum glacial, all paleo-channels were connected to current coastal and main land rivers of Kalimantan, Sumatra and Java Islands. In the study area especially at the north part, this feature was observed which occurred as parallel river pattern. This condition was also supported by field observation, proved by an extensive alluvium plain on land and mud flat at the sea.

According to Levson, V.M. and Giles, T.R., (1995) in paleo-channels, there are features that associated with coarse materials of gravels-cobbles and sands; such as point bars and mid stream bars. These authors pointed out that such features associated with coarse materials are the places for gold placer accumulations. This opinion is supported by the fact that specific density of gold is 18

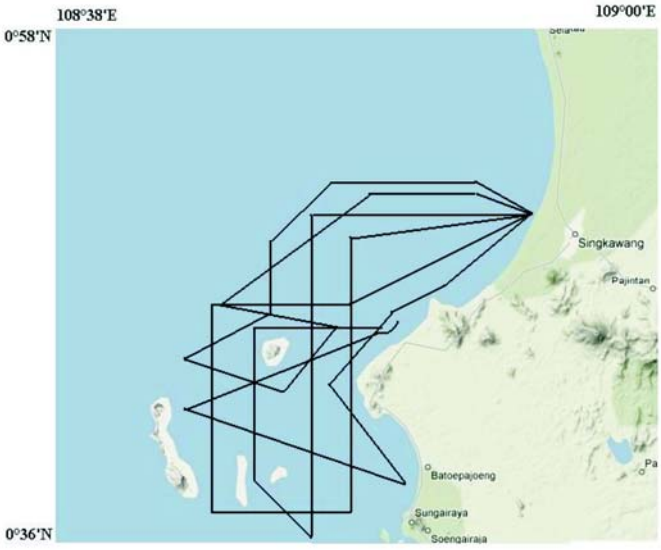

Figure 4. Seismic line map (Base map from terrain earthgoogle, 2010).

which only deposited in a high energy environment, same as coarse materials.

Identifications of bar features above, were not easily observed through the strata box seismic records. Instead, sequence stratigraphy concept developed by (Catuneanu, 2006) was applied to analyze sediments filling the channels. In this paper, some analyzed records were performed. This concept was meant to identify placer deposits genetically, in the context related with unconformities formed during coastline movements in the events of regression and transgression. Figure 5 explains the sequence stratigraphy.

RESULTS

Paleochannels resulted from seismic records interpretations are shown in Figure 6. In general, the channels directed to the northwest resemble to the regional paleochannels for northwestern of Sunda Shelf (Figure 2).

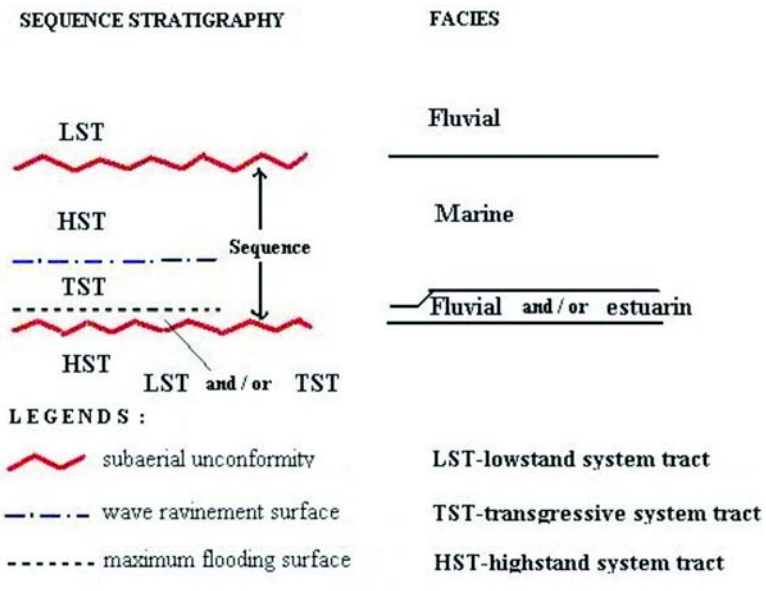

Figure 5. Sequence stratigraphy states rock units based on event significances of its bounding surfaces (Catuneanu, 2006)

As observed, the parallel pattern of the paleochannels in the north is following relatively Recent coastal parallel river pattern in a very extensive alluvial plain. Paleochannels in the southern part of the study area tend to radiate surround cone-shaped islands especially Kabung Island (highest point 297 meters above sea level - asl) and Lemukutan Island (366 meters asl) (Figure 6).

In the north, the width of the northernmost paleochannel measured from seismic records are closed to Recent river width of Singkawang River is 175 meters compared to 165 meters. In the south, the dimension reached approximately 500 meters width (Figure 7). While, the sediment thickness on paleochannels in the north thicker than south of study area.

In the north, marine recent sediments filled in paleochannel of 10 meters thick. It is a very large mud flat as an extension of coastal alluvial plain; and consequently there is soft and unconsolidated seabottom recent sediments.; while in the south, these sediments were thin until none. The differences are possibly driven by several conditions such as lithological resistance, seafloor morphology, current, and non existence of big river.

Paleo river maturity is also different; where U shapes of channel valley in the north show an older erosional stadium; while V shapes demonstrate a younger river stadium in the south.

Figure. 7 shows repetition of unconformity

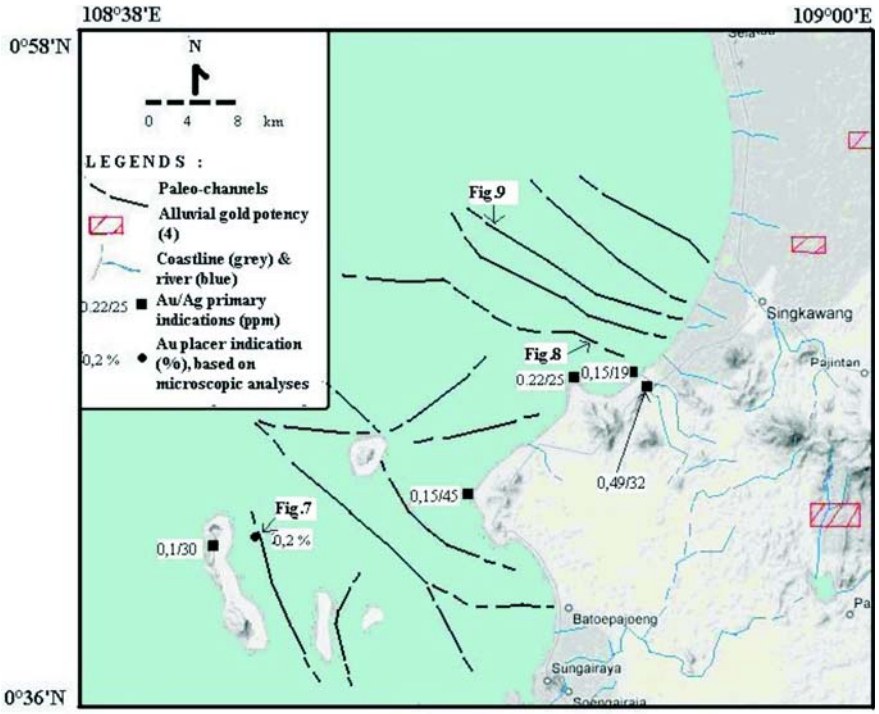

Figure 6. Paleo-channels pattern of study area, integrated with Au/Ag primary and placer indications (Aryanto et al., 2008); Fig. 7, 8 and 9 in this figure, related to seismic interpreted records.

surfaces in the seismic profile interpreted as sea level changes recorded in the Pleistocene to Holocene sediments. It appears as sediment sequences separated by erosional truncational. Each sequences show continuing sedimentation. These features are termed paraconformity. It can be observed that sequences boundary between Pleistocene and Holocene sediments is a distinct erosional surface. This erosional surface according to stratigraphy sequence is a subaerial unconformity which potential for gold placer deposit accumulations.

Other genetic unconformities noticed in the seismic profile are marine erosional regressive surface and transgressive ravinement surface.

Just above subaerial unconformity (Figure 7), according to the sequence stratigraphy, is a low stand system tract (LST), of fluvial or estuarine environment. This fluvial environment is an indication of landmass during low sea level, thus also potential gold placer accumulations. The following transgression system tract (TST) over LST is interpreted as a surface formed by wave scouring during sea level rise. On top of TST is a high stand system tract or HST. Sediments on HST, based on seabottom sample of SKWL 24, are megascopically greenish gray slightly muddy sand, very fine to moderate grain sizes, subangular to subrounded grains, composed mainly of quartz, mafic minerals, and mollusc shells. Based on grain size analyses (Folk, 1980), is sandy silt consisted of fractions of

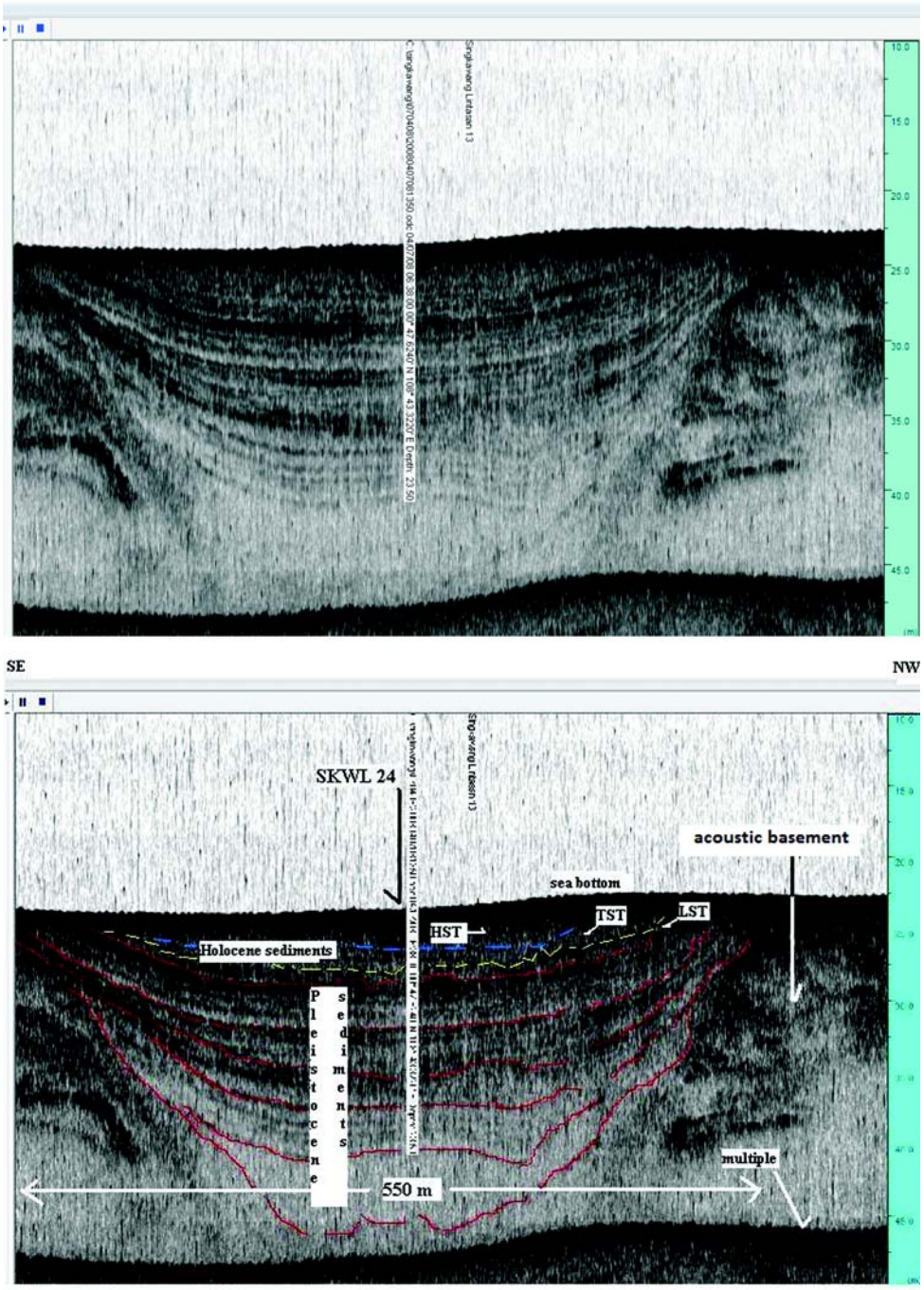

Figure 7. Original and interpreted seismic records. SKWL 24 is a sea bottom location sample.

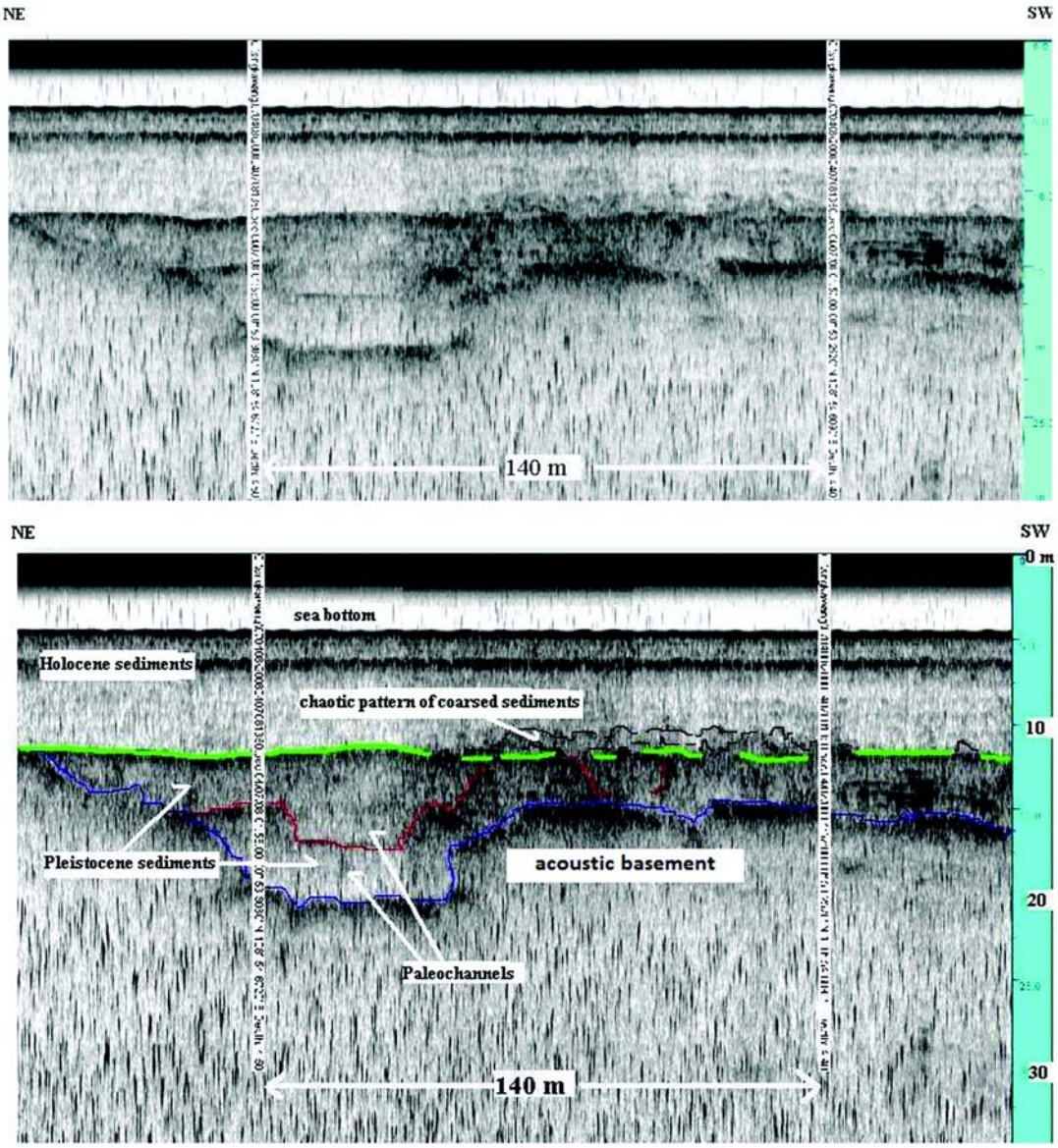

Figure 8. Original and interpreted records closed to the highest primary gold content.

sand 43.4%, silt 54.3% and clay 2.3%. Petrographic examination of the sample shows gold grains about 0.2%.

Physiographic features of gold sample SKWL 24 is characterized by seabottom steep morphology on bathymetry data, and closed to primary sources in Lemukutan Island. Sampling at outcrop on the island (SKP/OC-053) which analyzed using Atomic Absorption Spectroscopy (AAS) found gold and silver indications; Au 0.1 ppm and Ag 30 ppm.

Paleochannel dimension of Figure 7, which reached approximately 550 meters width and sediment fill about 20 meters thick, interpreted as the part of main paleochannels (Figure 2) that terminated to South China Sea.

Interpretation of seismic record in Figure 8, resulted in two obvious paleochannels below truncational surface. This erosional surface is a distinct subaerial uncorformity between Pleistocene and Holocene sediments. Chaotic reflector pattern just above this surface is accounted for paleocoast associated with coarse fraction sediments that possibly also accumulated gold placer. Field observation during survey, the coast closed to this record site consisted of coarse sediments of sand to boulder sizes.

Figure 9 shows a paleochannel in the north of study area. The Holocene sediments were also treated using sequence stratigraphy. Immediately above Holocene – Pleistocene erosional surface or subaerial unconformity

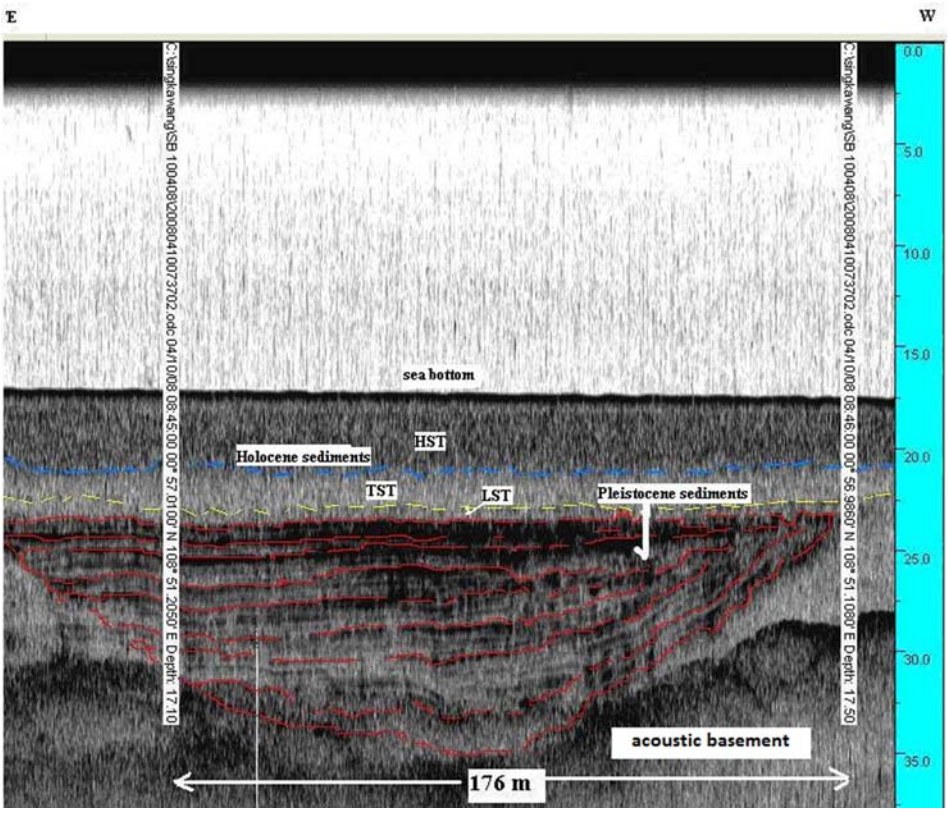

Figure 9. Original and interpreted seismic records north of study area. U-shaped of paleovalley indicates river mature stadium.

was deposited low stand system tract (LST) of fluvial environment. Accordingly above LST were placed a transgressive system tract (TST) and a high stand system tract (HST). On the other hand, sequence boundaries of sediments in the paleochannel shows rough surface which is resulted from sea level changes during Pleistocene Epoch. This rough surface can also be related to placer depositions.

DISCUSSIONS

Occurrences requirements for gold placer accumulation are primary gold sources such as gold-quartz veins, auriferous sulphide deposits or previous placers. Long time chemical and physical weathering to liberate gold grains from its source rocks is also important. Besides, gravitational gold particle concentrations that involved water as transportation media is necessary. Finally, long lasting stable surface and bed rock conditions to allow significant gold accumulations is needed.

Considering neccesities above, it seems that the study area fulfill the requirements for gold placer accumulation. The islands, coastal and hinterland of Singkawang have primary gold sources. Oligocene to Recent chemical and physical weathering (about 36 ma until now) is a long time processes to liberate gold grains from its source rocks. Gravitational gold transportation which involved water media is evidence from many rivers in Singkawang area upstreamed to primary gold area and mouthed to Singkawang Sea. Long lasting stable surface and bed rock conditions since 36 ma gave no significant geology activities such as earthquakes and volcano eruptions.

Placer deposit in seabottom east of Lemukutan Island, sample number SKWL 24, show transportation closed to its primary source. Sampling campaign in the island found out the evidence of gold primary sources.

CONCLUSIONS AND SUGGESTIONS

Results of seismic records analyses, can be mapped subseabottom paleochannels in Singkawang Waters. At the north, these paleo-channels are interpreted as extend of Recent coastal area rivers mouthed at Singkawang Waters; while at the south among the islands, paleo-channels tend to radiate surround conical islands.

The potential gold placer deposits, especially in the south among the islands, that seems promising based on data performances. Comparison with geological conditions of coastal and hinterland Singkawang area had long history of alluvial gold minings since the end of 18^{th} century. This potential would be more obvious if followed up study conducted at much smaller area possibly surround Lemukutan Island. Besides using high resolution shallow seismic, offshore geological drillings on seismic ship tracks will assist seismic interpretation and expose more subseabottom gold potency.

The depositional environments of gold placer in the study area are fluviatile and paleocoast. Gold accumulations at those two environments took place during low sea level, where during that time was formed a paleochannel system in the Sunda Shelf as traps of this precious mineral.

This island would be the next target for detail prospection possibly in fiscal year 2011.

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